

Studies on the glaciation of
Eastern Svalbard and the Barents
Sea. (The Stockholm University
Svalbard Expedition, 1966.) by
Weston Blake Jr.

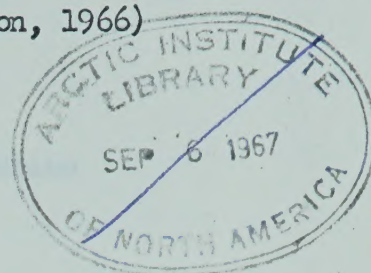
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STUDIES ON THE GLACIATION OF EASTERN SVALBARD AND THE BARENTS SEA

(The Stockholm University Svalbard Expedition, 1966)

by Weston Blake, Jr.⁺



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Introduction

The main purpose of the Stockholm University Svalbard Expedition, 1966 was to gather information about the extent of the area in eastern Svalbard that was ice-covered during the last glaciation. It was also hoped that some progress could be made toward answering the question of whether or not a connection existed between the Scandinavian Ice-sheet and the ice-caps over the European Arctic islands.

Organization

The expedition was organized by Prof G. Hoppe and Dr V. Schytt of the Dept of Physical Geography, Stockholm University, to continue the work of the Swedish Glaciological Expedition to Nordaustlandet, 1957 and 1958 (leader, V. Schytt).^x Preliminary expeditions visited Björnöya and Hopen during 1965. The expedition numbered 18 and was supported by an 11-man group from the Swedish Army Helicopter School. Members are listed below, with nationality given for non-Swedish participants.

⁺ Geological Survey of Canada, Ottawa 4, Ontario. The writer's participation in the expedition was made possible by a grant from the Arctic Institute of North America, under contractual arrangements with the Office of Naval Research. The expedition itself was financed mainly by Statens Naturvetenskapliga Forskningsråd (the Swedish Natural Science Research Council). Appreciation is expressed to Prof Hoppe and Dr Schytt for their helpful comments during the preparation of this report, and to H. Billeström for his assistance in the field.

G. Hoppe, Co-leader (2 July-4 August), glacial geomorphology
V. Schytt, Co-leader, operations chief, glacial geomorphology
M. G. Grosswald (USSR), Glacial geomorphology
C. Schlittler (Switzerland), Cook

Southern Group

B. Strömberg, Leader (2 July-4 August), glacial striae
P. Knape, Leader (August), glacial geomorphology
P. Björklund, Assistant
O. Melander, Assistant

Northern Group

W. Blake, Jr. (USA), Leader, glacial geomorphology
H. Österholm (Finland), Glacial striae
L. Westman, Botany
H. Billeström, Assistant

Lake Group

H. Hyvärinen (Finland), Leader, lake sediments
S. R. Ekman, Technical operations (2 July-4 August)
A. Fleetwood, Water analysis (2 July-4 August)
F. Goldberg, Assistant

Ice-cap Group

E. Palosuo (Finland), Leader, ice-crystallography
P. Vähäsarja (Finland), Assistant

Helicopter Group

B. Hasselrot, Leader, pilot
T. Frick, Pilot
G. Krulle, Pilot
O. Lundberg, Pilot
I. Yngve, Mechanic
L. Bäckström, Mechanic
H. Brandt, Mechanic
G. Hyllendahl, Mechanic
A. Carlström, Doctor (2 July-4 August)
G. Karner, Doctor (August)

After traveling north from Stockholm to Narvik by train on 2 July, the expedition members sailed from Harstad, Norway aboard Binny (Store Norske Spitsbergen Kulkompani) on 4 July and arrived in Longyearbyen on 6 July. Three turbine helicopters, two Alouettes and one Agusta Bell 204B, were carried north in the hold and were unloaded and made operative in Longyearbyen. The expedition continued northward aboard Nordsyssel

and Signalhorn, both ships used under a cooperative arrangement with Norsk Polarinstitut by which the Swedish expedition provided helicopter assistance to various Norwegian field parties. No ice was encountered along the west coast of Vestspitsbergen, but as the ships progressed eastward along the north coast ice conditions became increasingly difficult. After Nordsyssel had spent two days in the vicinity of Moffen, all fuel, provisions, and equipment were transferred onto adjacent ice floes and then air-lifted the remaining 70 km to Kinnvika, the base of the Swedish-Finnish-Swiss IGY Expedition in outer Murchisonfjorden, Nordaustlandet, which was also used as the base for operations in 1966. Nordsyssel then returned to Longyearbyen, but Signalhorn succeeded in finding a way through the ice to Kinnvika. All personnel and most of the expedition's stores reached Kinnvika by 12 July, and field parties were set out by helicopter the following day.

Four groups worked in different parts of eastern Svalbard. In July the moving of these groups between camp sites was accomplished by helicopter; in August both southern and northern groups operated mainly with small boats (the northern group's boat was flown out from Kinnvika between the floats of the Bell helicopter) equipped with outboard motors. The excellent helicopter support made it possible to visit many areas that are often difficult of access by boat because of sea ice conditions. Fuel depots for the helicopters were put out by the Bell (using a net) in some cases, but larger depots were set out by Signalhorn. Three hundred 185-litre drums of aviation kerosene were shipped north; of these 296 were used. Maximum consumption of fuel was approximately 180 litres per hour for the Alouettes and 300 litres per hour for the Bell. Each of the three helicopters flew between 80 and 85 hours in Spitsbergen. With few exceptions flights were made with at least two helicopters operating in the same general vicinity. The Bell was always flown with a mechanic on board, and if the two Alouettes operated together, a mechanic accompanied one helicopter. All three helicopters were equipped with floats, which reduced both their speed and their load-

capacity, but which were necessary because much flying was done over the sea.

The Southern Group worked successively in southern Nordaustlandet, Kong Karls Land, Wilhelmöya, and Lomfjorden on the west side of Hinlopenstretet, and finally made a traverse of the entire length of Wijdefjorden (north to south) by boat.

The Northern Group worked eastward from Lady Franklinfjorden along the north coast of Nordaustlandet as far as Zordragerfjorden. Further progress eastward by boat was prevented by heavy pack ice, but a long helicopter flight from Kinnvika at the end of the season made it possible to visit söre Repöya; Finn Malmgrenfjorden, and Wahlenbergfjorden in one day.

The Lake Group carried out successful coring of bottom sediments in a large number of lakes near Kinnvika, south of Murchisonfjorden, in Rijpdalen between the two ^{main} ice-caps, east of Rijpfjorden, and in Ny Friesland. During the early part of the summer coring with a Livingstone sampler was carried out from the lake ice; after the lakes became free of ice operations were conducted from a rubber boat.

The Ice-cap Group worked mainly on the top of and along the western margin of Vestfonna, the smaller and western of the two main ice-caps in Nordaustlandet. Particular emphasis was placed on continuing the crystallographic work begun in 1958. In cooperation with Norsk Polarinstitut a motor-toboggan traverse across Vestfonna to Rijpdalen with a gravity metre was made, following the route of the 1958 seismic-glaciological traverse as closely as possible (see Ekman, 1960; Palosuo and Schytt, 1960).

By 24 August all field parties except the Southern Group had return to Kinnvika. The expedition was evacuated by Andenes (Royal Norwegian Navy) and Signalhorn on 27 August. The helicopters flew to Longyearbyen on 27 August also, stopping en route to lift the Southern Group from the head of Wijdefjorden over to the head of Dicksonfjorden, whence this group continued by boat to Longyearbyen. Most expedition personnel left Longyearbyen on 29 August aboard Andenes, arrived at Tromsö on 31 August, and

reached Stockholm by train from Narvik on 2 September. The helicopters were shipped south on the deck of Bernes (Store Norske Spitsbergen Kulkompani).

Preliminary results

A great deal of data was gathered by the expedition, and a considerable time will be necessary for all the material to be worked up. Preliminary results on two of the main subjects of study can be given here, however, and the reader is also referred to two accounts already published in Sweden (Hoppe, 1966; Schytt, 1966).

Studies of striae and other motion indicators show that, in general, ice flow was to the north along the north coast of Nordaustlandet, with some deviations due to the influence of topography. On the northwest coast ice flow was dominantly toward the northwest (Lady Franklinfjorden) and west (Murchisonfjorden). In each of these areas the pattern of motion was what would be expected if the present-day ice-caps were more extensive. Of special interest is the evidence found in the southern part of Hinlopenstretet for ice flow to the northwest, up this strait, corroborating observations made in the same area by the Swedish-Russian Arc-of-Meridian Expedition, 1899-1902 (De Geer, 1923; cf. De Geer, 1900). At several places on Hopen, on the other hand, observations by H. Österholm in 1965 indicated former ice flow from the northeast (Schytt, 1966). The data from Hinlopenstretet and Hopen indicate that during the last glacial maximum a considerable area southeast of Nordaustlandet, now shallow sea, must have been covered by an ice-cap.

Support for this hypothesis is provided by the tilt of certain raised marine features. In particular, one prominent strandline, cut into bedrock in many places during one or more of the Tapes transgressions (see Marthinussen, 1945, 1960, and 1962 for information on these transgressions in northern Norway) is characterized by the presence of abundant dark brown pumice, which presumably has floated to Spitsbergen with the Gulf Stream, perhaps from Iceland (see Bäckström, 1890;

Noë-Nygaard, 1951). Donner and West (1957) were the first to use this reference level, during the 1955 Oxford University Expedition to Nordaustlandet, and their work in the northern part of Hinlopenstretet showed that the pumice level rose to the southeast. The writer expanded on their work in 1957 and 1958 and was able to demonstrate a similar rise of the pumice level toward the southeast in the Murchisonfjorden - Lady Franklinfjorden area (Blake, 1961, 1962). In 1966 it proved possible to find pumice all along the north coast, and precise leveling was carried out at 24 stations, as well as at a number of additional sites on the northwest coast. From a minimum of ca. 5 m on Lågöya, the altitude at which the pumice occurs rises to 10 m in the innermost parts of Murchisonfjorden and Lady Franklinfjorden, to over 13 m at Planciusbukta and middle Zordragerfjorden, to ca. 19 m at the southern end of Rijpfjorden, and to over 20 m at the easternmost point reached on the north coast, Finn Malmgrenfjorden.

Pumice becomes scarcer to the south, although Donner and West (1957) found considerable amounts at altitudes between 13 and 14 m on ^athe small peninsula ~~on the north side~~ at the mouth of Wahlenbergfjorden. In 1966 the Southern Group recorded it at ca. 28 m on Wilhelmöya, south of Nordaustlandet, and at ca. 13 m in the southern part of Wijdefjorden. Unfortunately the prominent pumice level was not found in southern Nordaustlandet or on Barentsöya, Hopen, or Kong Karls Land, although all four areas display evidence of considerable postglacial uplift (e.g., see Thompson, 1953; Büdel, 1962; Grosswald et al., 1967).

Several new radiocarbon age determinations have been obtained on samples of driftwood and whale bone imbedded in the beach shingle of the same prominent strandline on which the pumice occurs. In each case the dated material was found in close association with pumice fragments. The pertinent data are given below:

Table 1

Locality (see accompanying map)	Coordinates		Material	Approx. alt. of sample (metres)	Lab. dating no. ¹	Age (radiocarbon years before 1950)
	Lat.	Long.				
outer Murchisonfjorden	80°02.5' N	18°08' E	wood	8	GaK-1216	7010 ± 100
Planciusbukta	80°13' N	21°40' E	wood	13.5	GaK-1212	7490 ± 100
inner Rijpfjorden	80°07' N	21°52' E	wood	16	GaK-1211	6490 ± 100
outer Zordragerfjorden	80°26' N	22°50' E	wood	12.5	GaK-1210	6450 ± 100
middle Zordragerfjorden	80°23.5' N	22°50' E	wood	13.5	GaK-1214	7330 ± 100
Wilhelmöya	79°06' N	20°32' E	bone	28	St-2293	6780 ± 100

¹ All determinations with the designation GaK- were carried out at the radiocarbon dating laboratory at Gakushuin University, Tokyo, Japan, through the kindness of Prof. K. Kigoshi. The sample from Wilhelmöya was collected by P. Knape and dated at the Radioactive Dating Laboratory, Stockholm, Sweden. The Gakushuin ages are computed using a C¹⁴ half life of 5570 ± 30 years; the Stockholm age is based on a C¹⁴ half life of 5568 ± 30 years. Both laboratories use National Bureau of Standards oxalic acid as a standard.

These ages, especially GaK-1210, GaK-1211, GaK-1216, and St-2293, agree closely with six dates obtained earlier on samples of driftwood and whale bone from the same strandline with pumice in the Murchisonfjorden - Lady Franklinfjorden area (Olsson, 1959, 1960; Blake, 1961, 1962; Olsson and Blake, 1962). The earlier dates, in revised form, are listed in Table 2. The new dates confirm the conclusion, based on field evidence, that the prominent cut strandline with abundant pumice was formed during the same time interval in all areas.

Table 2

Locality accompanying map)	Coordinates		Material	Approx. alt. of sample (metres)	Lab. dating no. ¹	Original	Revised
	Lat.	Long.				age (radiocarbon years before 1950)	age years
Murchisonfjorden	79°59' N	18°22' E	wood	9	U-116	6650 ± 110	6770 ± 120
Murchisonfjorden	79°58.5' N	18°20' E	wood	8.5	U-36	6490 ± 110	6620 ± 110
Murchisonfjorden	80°02' N	18°20' E	wood	8	U-111	6740 ± 110	6860 ± 120
Murchisonfjorden	80°03' N	18°08' E	wood	8	U-107	6200 ± 100	6330 ± 110
Murchisonfjorden	80°03' N	18°08' E	bone	8	U-110 ²	6380 ± 150	6500 ± 160
Lady Franklin- fjorden	80°12' N	18°42' E	wood	6.5	U-112	6900 ± 110	7030 ± 120

determinations were carried out at the radiocarbon dating laboratory at the Institute of Physics, Uppsala University, Sweden, through the kindness of Dr. I. U. Olsson. All ages are based on a C^{14} half life of 5570 years. The revision of the dates was necessitated by a change in standard - from a piece of old Swedish elm to NBS oxalic acid (Olsson et al., 1961; revised list of dates distributed by I. U. Olsson, March 1966).

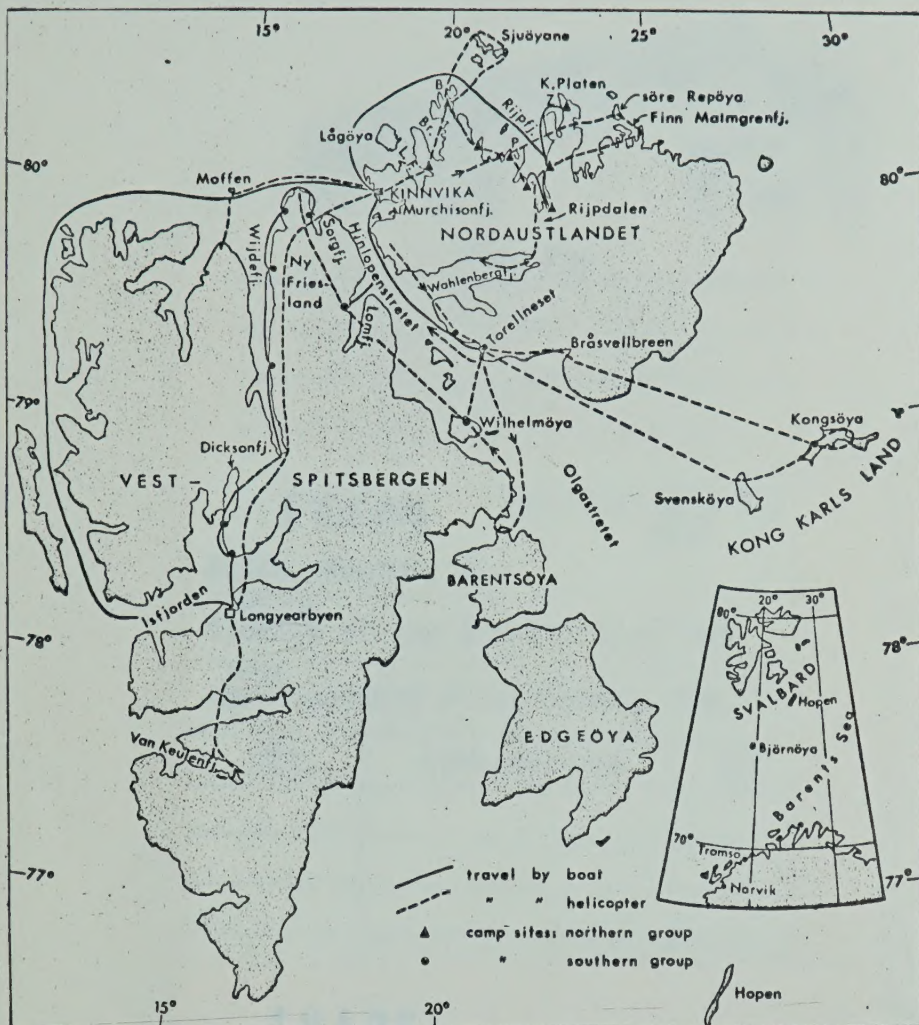
This age determination is on the organic fraction of whale bone after complete combustion.

The independent evidence of features indicating directions of ice flow and the tilted raised strandline with pumice permits the conclusion that at least the northern part of the Barents Sea was covered by an ice-cap during the last glaciation. In addition these data indicate that at the glacial maximum the ice was thicker over the area that is now shallow sea than over adjacent Nordaustlandet or Vestspitsbergen. Whether or not this ice coalesced with the Scandinavian Ice-sheet is not clear as yet, and perhaps the problem can be resolved only by studying and dating the bottom sediments in the Barents Sea (cf. Ignatius, 1959).

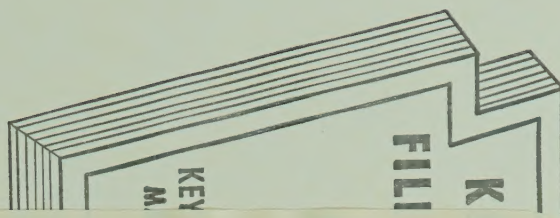
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Map showing area of operations and main routes traveled in 1966. Abbreviations: L F - Lady Franklinfjorden; Br - Brennevinsfjorden; B - Beverlysundet; P - Planciusbukta; Z - Zordragerfjorden.



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